Consommation et Corporations Canada
Consumer and Corporate Affairs Canada
Bureau des brevets
Patent Office
Ottawa, Canada K1A 0C9

(21) (A1) 2,045,070
(22) 1991/06/20
(43) 1992/02/01

5,022,069

(51) INTL.CL.[5] A61M-036/04; A61M-025/01

(19)(CA) **APPLICATION FOR CANADIAN PATENT** (12)

(54) Control System for DSA and PTCA

(72) Mizoguchi, Kazuaki - Japan ;

(73) Getz Bros. Co., Ltd. - Japan ;

(30) (JP) 201213/90 1990/07/31

(57) 3 Claims

Canada

ABSTRACT

A syringe used in DSA (Digital Subtraction Angiography) and PTCA (Percutaneous Transluminal Coronary Angioplasty) is provided with a syringe drive unit driven by a motor. The motor velocity is controlled by a hand-control or by a foot-control. The allowable ranges of control are preset in the control unit and displayed on a display unit together with the real control data. In the replenishment of the contrast medium in the syringe, the three-way cock is automatically controlled.

CONTROL SYSTEM FOR DSA AND PTCA

BACKGROUND OF THE INVENTION

The present invention relates to a control system for DSA (Digital Subtraction Angiography) and PTCA (Percutaneous Transluminal Coronary Angioplasty). Diagnosis by DSA and methods of medical treatment by PTCA have become very popular in these years.

Throughout these medical operations of DSA and PTCA, the operated portion is observed by an X-ray monitor television display. For one example of PTCA, a guide catheter is first inserted into the lumen of the coronary artery, and subsequently, a balloon catheter is pushed to a position where the balloon is at the target coronary artery. Here the balloon of the balloon catheter is inflated to expand the stenosed coronary artery lumen.

Then a syringe is pushed little by little by manually adjusting the push amount to inject a contrast medium to the aperture between the guide catheter and the balloon catheter.

When the whole volume of the contrast medium contained in the cylinder of the syringe is emptied, the contrast medium must be replenished from a contrast medium reservoir. In this replenishment, a three-way cock must be manually operated to connect the syringe to the reservoir or to the guide catheter.

As described in the foregoing paragraphs on PCTA, the

manipulation on pushing the syringe for positioning the balloon catheter requires a very fine adjustment, and the pressure injection of the contrast medium requires a relatively large force for a hand-exerted force.

Moreover, the manual turnover of the three-way cock in the replenishment is very troublesome to the operator.

And, thus the contol of the syringe has been a burden which gives the operator an extreme tension and exhaustion.

Especially in brain DSA, the operator will be exposed to a fairly large amount of radioactivity, because the operator must be kept close to his patient.

SUMMARY OF THE INVENTION

Therefore, an object of this invention is to provide a power-drive for a syringe, in which the drive unit is controlled through a hand-control or a foot-control. An electric circuit translates a fairly large displacement in the hand- or foot-control to a very fine displacement of the syringe piston. And, since the syringe piston is displaced by a motor of the syringe drive unit, the high pressure exerted on the syringe piston has no relation on the force for driving the hand-control or the foot-control.

Another object of this invention is to provide means for presenting necessary informations to the operator. To this object, a control unit and a display unit are provided. The allowable ranges of the syringe control can be preset on the control unit, and these preset ranges are displayed on the display unit together with the real values of the

control. Comparing these values on the display unit, the operator can control the stroke of the hand-control or the foot-control to exert most adequate controls to the syringe.

Still another object of this invention is to achieve an automatic control of the three-way cock.

These and other objects, features and advantages of the present invention will become clear from the following description of the preferred embodiments in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 shows a perspective view of an embodiment of the present invention,

Fig. 2 shows an example of the electric circuit of the syringe drive unit in Fig. 1,

Fig. 3 shows a perspective view of another embodiment of this invention,

Fig. 4 shows a section of the pneumatic switch of Fig. 3 in its injection mode,

Fig. 5 shows the same section of the pneumatic switch in its replenishment mode,

Fig. 6 is a block diagram illustrating the necessary devices for PTCA in Trans-femoral method,

Fig. 7A~C show pictures displayed on X-ray monitor television screen.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

First referring to Fig. 6, devices necessary for PTCA will be explained. In Fig. 6, 1 is a pace-maker, 2 is a

guide catheter, 3 is an injection syringe, 4 is a balloon catheter, 5 is a guide wire, 6 is a pressurizing unit, 7 is a three-way cock.

The performance of the devices are described in connection with Figs. 7A~C. As shown in Fig. 7A, the guide catheter 2 is inserted in the lumen of the coronary artery. And then, the balloon catheter 4 is positioned where the balloon 9 is at the target coronary artery 10. (Refer to Figs. 7B and 7C). Here, the balloon 9 is inflated to expand the stenosed coronary artery lumen. After that, the syringe 3 is manually pushed to inject a contrast medium to the aperture between the guide catheter 2 and the balloon catheter 4.

Now referring to Fig 1, an embodiment of the present invention will be described. In Fig. 1, 11 is a syringe, 12 is a syringe drive unit, 13 is a control unit, 14 is a hand-control, 15 is a foot-control, 16 is a display unit, and 17 is a stand. In Fig.1 , devices which are not necessary for explaining this invention are omitted, but it must be understood that devices described in connection with Fig. 6 are to be equipped in accordance with the necessity.

Fig. 2 shows an example of the electric circuit of the syringe drive unit 12. And, in Fig. 2, 21 is a potentiometer for generating a variable voltage E, the value of the output voltage E is for an example, proportional to the position X of the hand- or foot-control, 22 is A/D (an analog-digital converter), 23 is a differentiator, 24 is an

absolute circuit, 25 is an adder, 26 is a register of modulo M, 27 is a control signal generator, and 28 is a pulse motor.

The absolute circuit 24 delivers the absolute value G of the time derivative dE/dt of the variable voltage E and the polarity signal S of dE/dt. The absolute value G is added to the register 26 at F cycles per second. Since the modulo of the register 26 is M, the overflow pulse from the register 26 has a frequency of FG/M pulses per second, that is, the frequency of the overflow pulse is proportional to the absolute value of dE/dt.

The control signal generator 27 controls the direction of the motor rotation by the polarity S and the motor speed by the overflow pulse, the velocity $d\theta/dt$ of the pulse-motor 28 is proportional to dE/dt. And, as the motor velocity is integrated to give the displacement of the syringe piston in the syringe drive unit 12, the displacement of the syringe piston is controlled to be proportional to the displacement of the hand- or foot-control, and the ratio of these two displacement can be so determined as to be most adequate in the controls.

As described in connection with Fig. 7, the operator of the control system for DSA and PTCA of Fig. 1, controls the hand-control 14 or the foot-control 15 carefully watching the screen of the X-ray monitor television as illustrated in Fig. 7.

Further to help the operator's control, a control unit

13 and the display unit 16 are provided in this embodiment.

Control parameters, for example, the allowable range of the amount of the push of the syringe, including the allowable ranges of speed of injection, the volume of injection, and the injection pressure, are preset in the control unit 13.

These data preset in the control unit 13 are displayed on the display unit 16. And the real data of the control, for example, the real injection speed,the injection volume, and the injection pressure are also displayed on the display unit 16. The operator can watch the display unit 16 and can compare the real data to its allowable range to control the hand-control 14 or the foot-control 15.

Fig. 3 shows another embodiment of this invention, and the same numerals in Fig. 1 indicate the same or the corresponding parts. And in Fig. 3, 18 is an air sensor, 30 is a contrast medium reservoir, 31 is a replenishment tube, 33 is an injection tube, 40 is a pneumatic switch, 50 is a bed-side stay, and 60 is an air compressor.

Fig. 4 shows a section of the pneumatic switch 40 of Fig. 3, and 42 is a piston, 44 is a spring, and 45 is an air tube. In its injection mode as shown i Fig. 4, the spring 44 is contracted by its own elastic force and opens the injection tube 33 and closes the replenishment tube 31.

When the piston of the syringe 11 is to its end position leaving no contrast medium in the syringe cylinder, the control unit 13 detects the condition, and actuates the

air compressor 60 to inject the pressurized air from the air tube 45. The injected air pushes the piston 42 against the force of the spring 44. This results in the opening of the replenishment tube 31 and closing of the injection tube 33. In this mode of the switch 40 as shown in Fig. 5, the contrast medium is replenished from the reservoir 30. And therefore, the operator will be exempt from the manual operation of the three-way cock 7 shown in Fig. 6.

Although only preferred embodiments are described in this specification, it should be understood that various changes and modifications may be made without departing from the spirit of this invention.

THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. Control system for DSA and PTCA, comprising a syringe or syringes for pushing catheters or injecting contrast medium in the artery lumen, an X-ray monitor television display for the observation of the operated portion, and a control unit for controlling overall performance of the system;

characterized in that:

at least one syringe of the syringes is provided with a syringe drive unit which displaces the syringe piston by an electric motor,

a hand-control or a foot-control which generates a controlled variable voltage for controlling said electric motor in said syringe drive unit,

control means for controlling the velocity of said motor in proportion to the time derivative of said generated variable voltage.

2. Control system for DSA and PTCA of claim 1, wherein allowable ranges for parameters of the syringe control are preset in said control unit and these parameters preset in said control unit are displayed on a display unit together with the real values of said parameters.

3. Control system for DSA and PTCA of claim 1, in which there is further provided a switch which automatically connects the output to the syringe to an injection path or to a path leading to a contrast medium reservoir.

FIG. 1

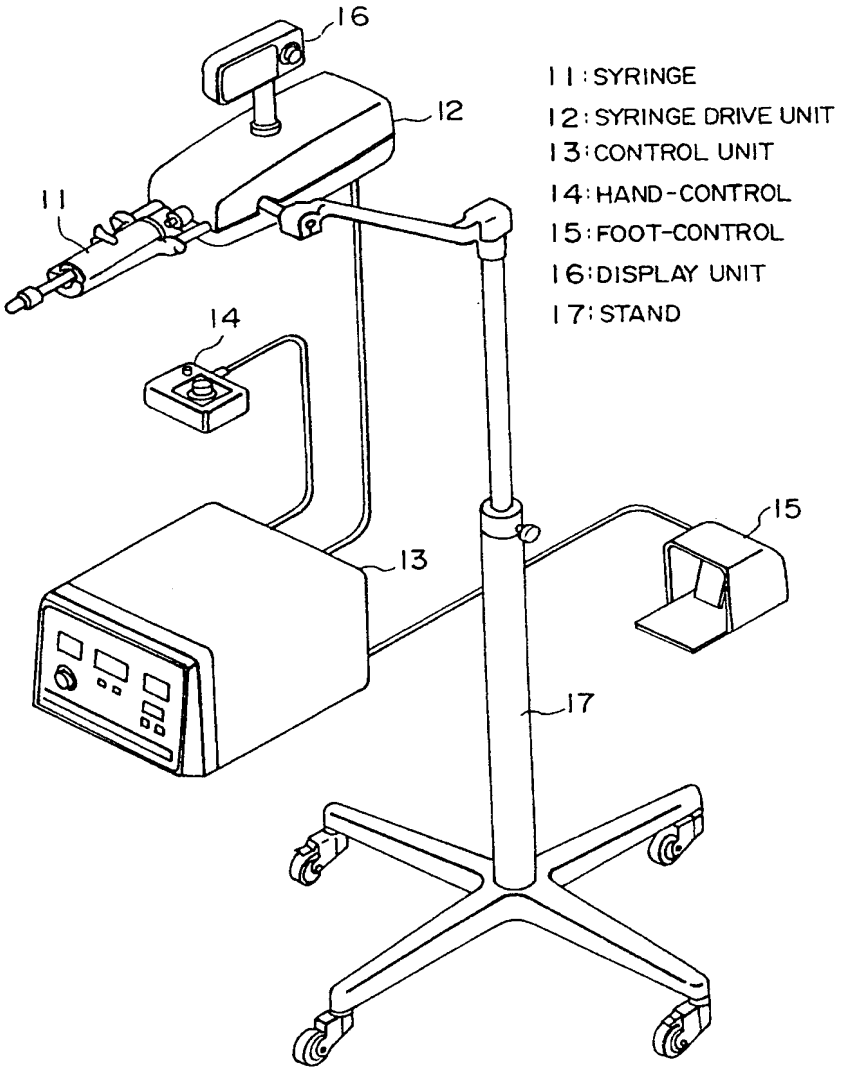

16
12
11
14
15
13
17
11: SYRINGE
12: SYRINGE DRIVE UNIT
13: CONTROL UNIT
14: HAND-CONTROL
15: FOOT-CONTROL
16: DISPLAY UNIT
17: STAND

FIG. 2

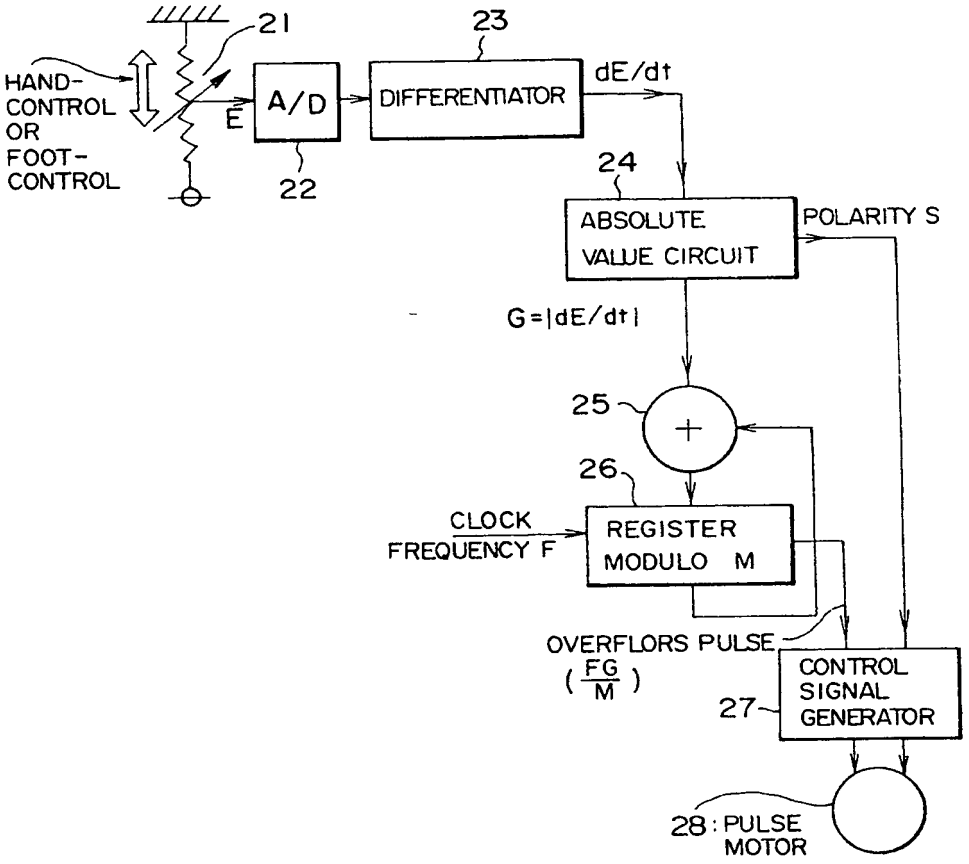

21
23
HAND-
CONTROL
OR
FOOT-
CONTROL
E
A/D
DIFFERENTIATOR
dE/dt
22
24
ABSOLUTE
VALUE CIRCUIT
POLARITY S
G=|dE/dt|
25
+
26
CLOCK
FREQUENCY F
REGISTER
MODULO M
OVERFLORS PULSE
(FG/M)
CONTROL
SIGNAL
GENERATOR
27
28: PULSE
MOTOR

FIG. 3

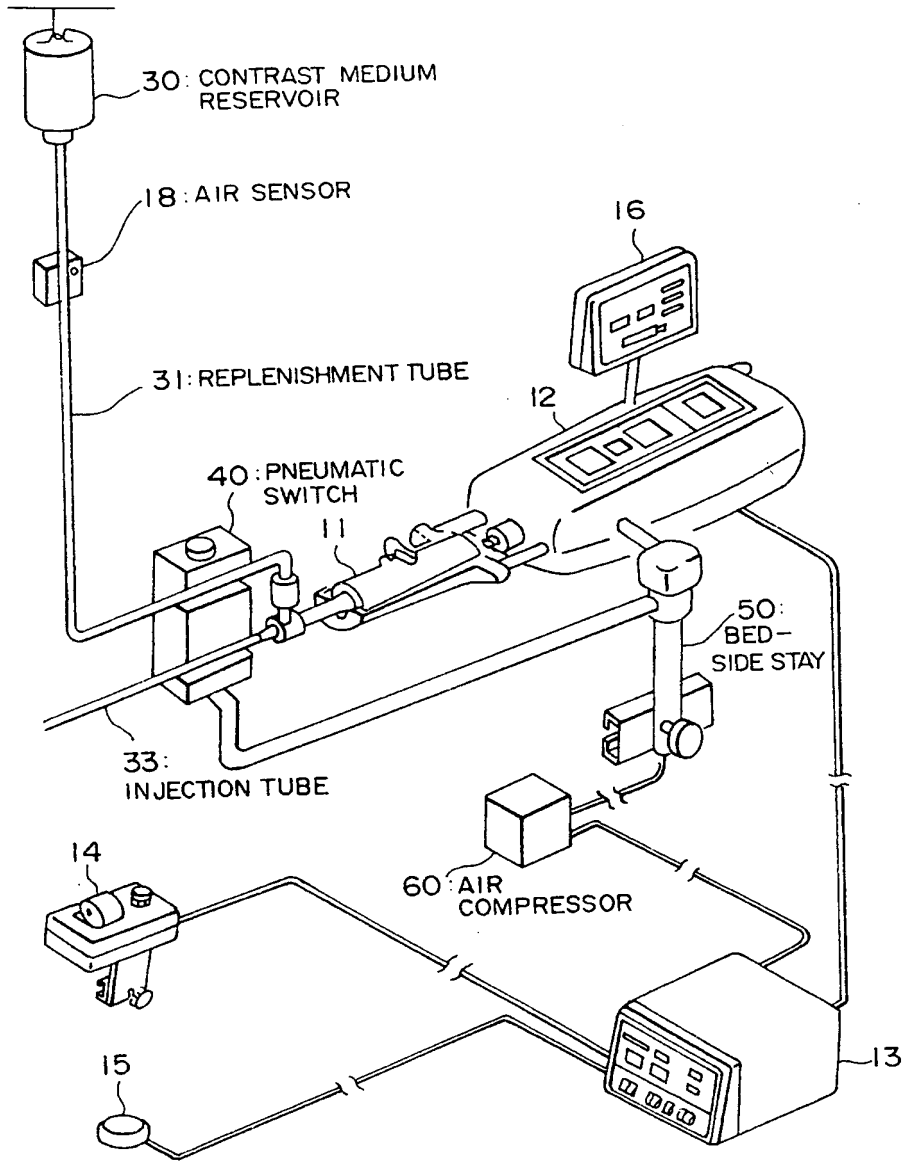

30: CONTRAST MEDIUM RESERVOIR
18: AIR SENSOR
16
31: REPLENISHMENT TUBE
12
40: PNEUMATIC SWITCH
11
50: BED-SIDE STAY
33: INJECTION TUBE
14
60: AIR COMPRESSOR
15
13

FIG. 4

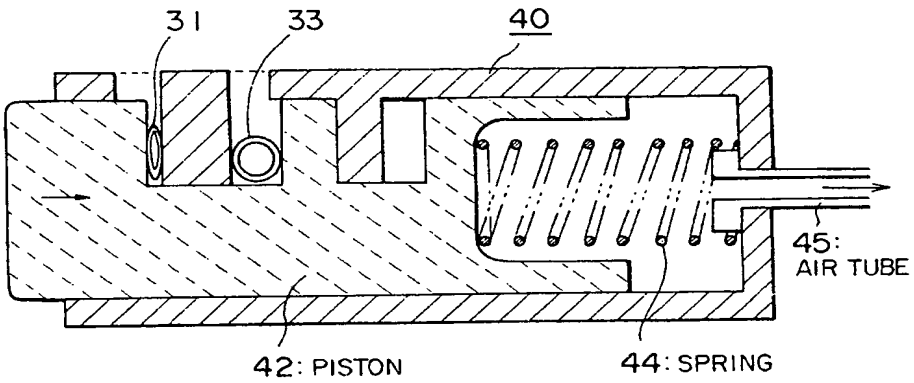


FIG. 5

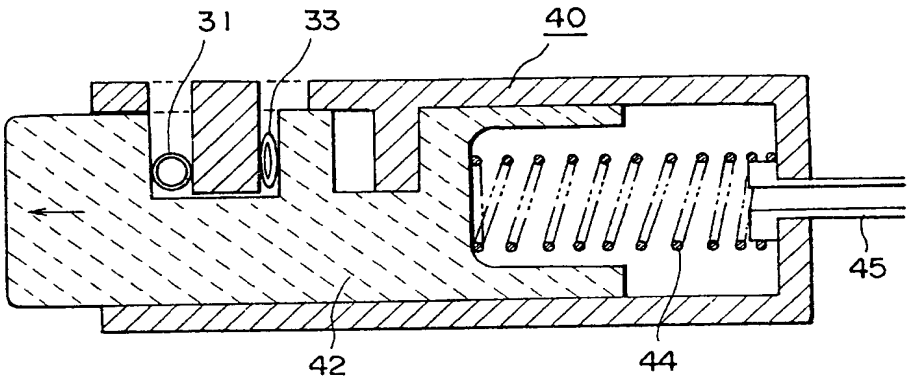
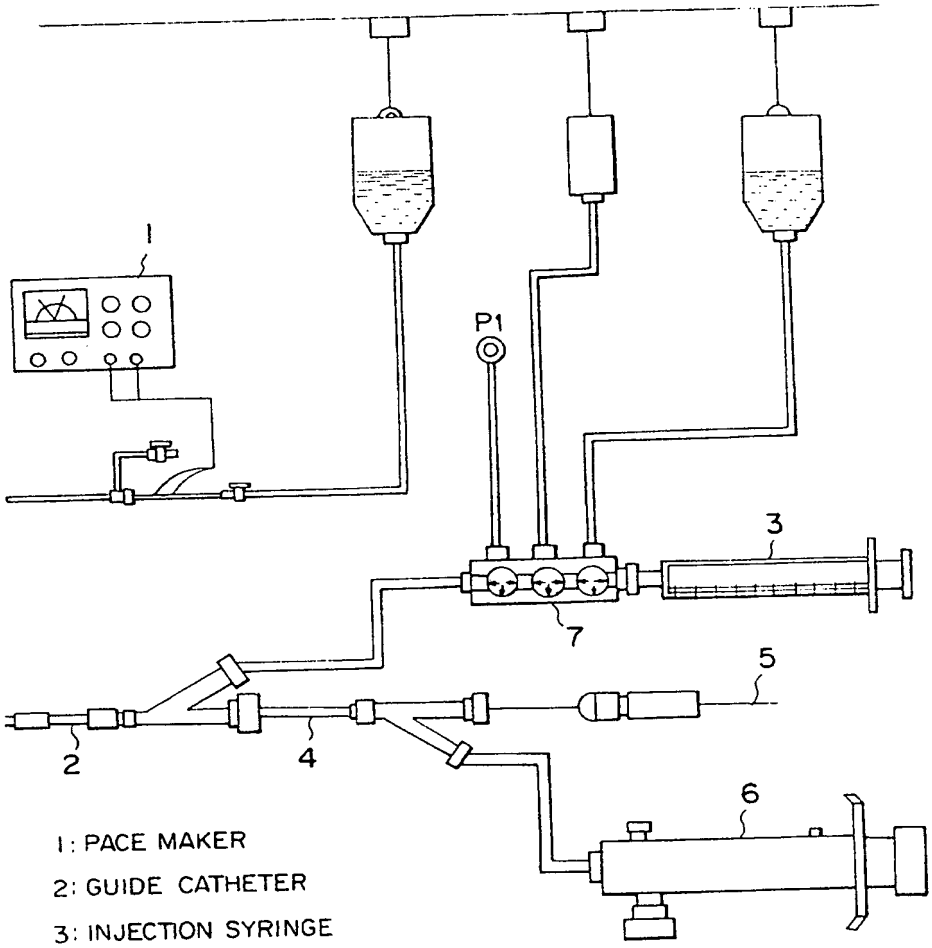
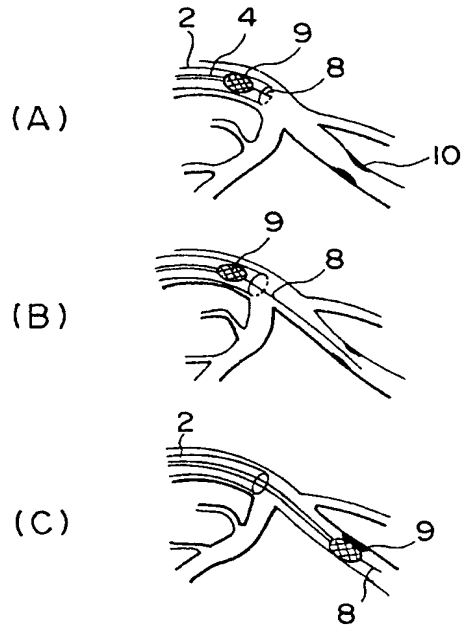


FIG. 6



1: PACE MAKER
2: GUIDE CATHETER
3: INJECTION SYRINGE
4: BALLOON CATHETER
5: GUIDE WIRE
6: PRESSURING UNIT
7: THREE-WAY COCK
P1: PRESSURE OF THE GUIDE CATHETER

FIG. 7



2 GUIDE CATHETER
4 BALLOON CATHETER
8 GUIDE WIRE
9 BALLOON
10 TARGET CORONARY ARTERY

Fraser & Clark